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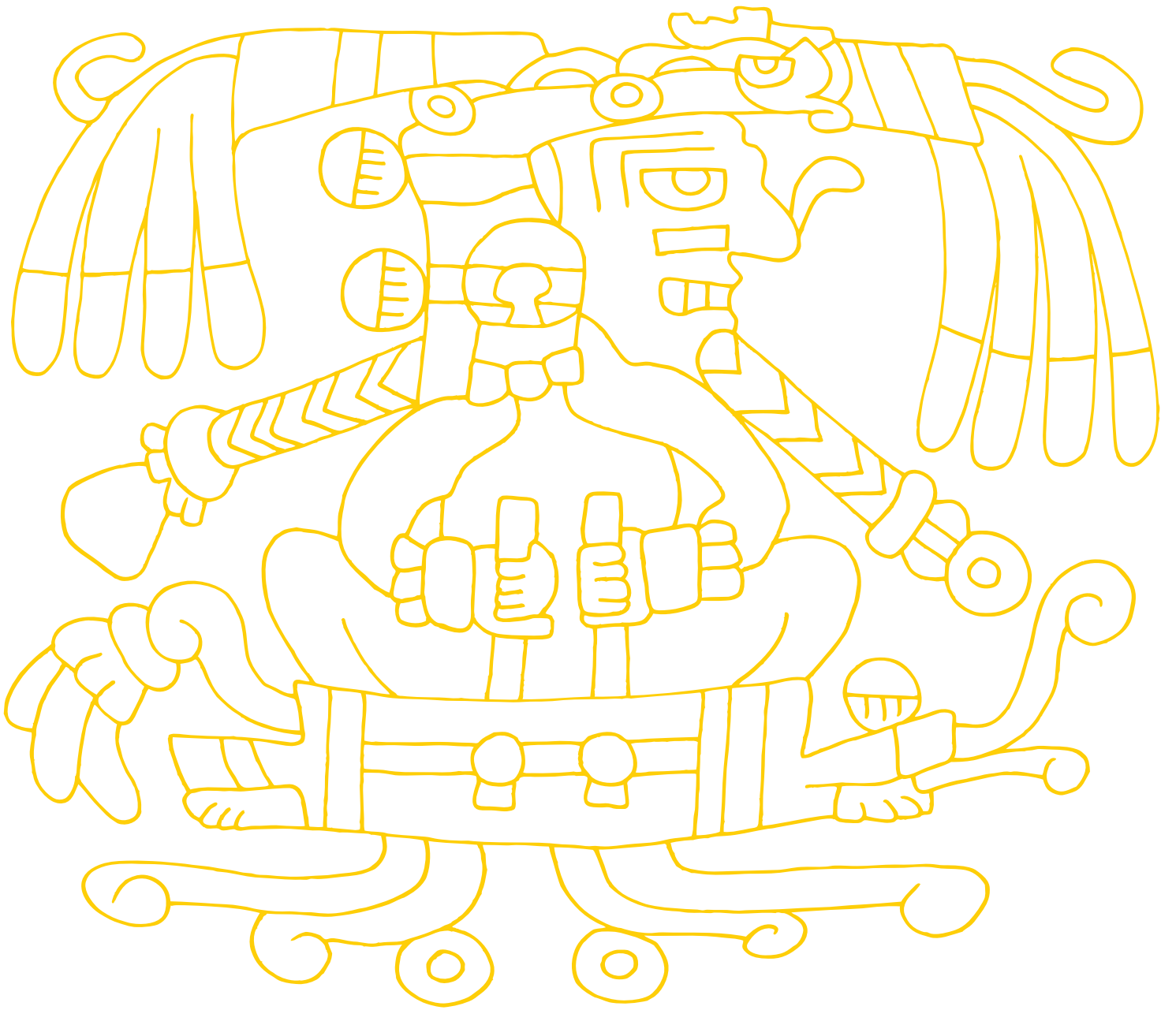

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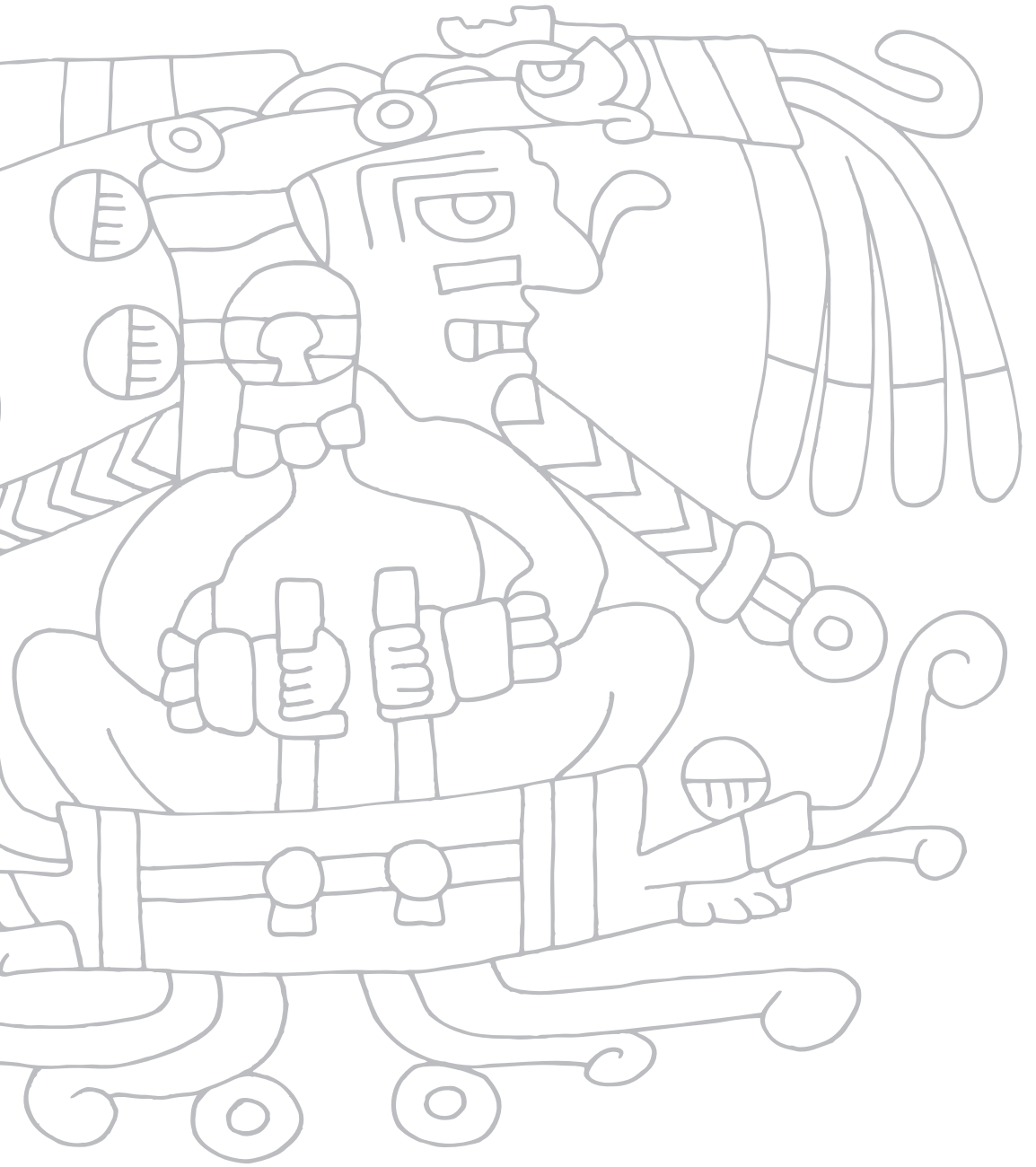

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Contents / Contenido

A Case Study of Maya Avian Ocarinas from Pook's Hill, Belize

Kristina Nielsen and Christophe Helmke

This paper examines the evidence of musical life at the Maya residential site of Pook's Hill in Belize. Whereas Pook's Hill was inhabited throughout the Classic period, we will focus on the rich remains of the Terminal Classic period (AD 830–950), immediately prior to the site's abandonment. Remnants of turtle shells and deer antlers, fragments of ceramic drums, and a large number of effigy ocarinas representing supernatural dwarves and animals testify to a rich musical culture that drew inspiration from the rainforest environment. We survey the musical life of this residential site, considering both the local variations demonstrated in the archaeological finds as well as its correspondence to broader Maya and pan-Mesoamerican musical expressions.

Este artículo examina la evidencia de la vida musical en el sitio residencial maya de Pook's Hill en Belice. Aunque Pook's Hill era habitado durante todo el período Clásico, nos centraremos en los ricos vestigios del periodo Clásico Terminal (830-950 d.C.) inmediatamente antes del abandono del sitio. Los restos de caparazones de tortuga y cuernos de venado, fragmentos de tambores de cerámica y un gran número de ocarinas efigies que representan enanos sobrenaturales y animales dan testimonio de una rica cultura musical que se inspiraba en el medio ambiente selvático. Examinamos la vida musical de este sitio residencial, teniendo en cuenta tanto las variaciones locales que se manifestaron en los hallazgos arqueológicos, así como su correspondencia con expresiones musicales maya y pan-mesoamericanas.

The archaeological site of Pook's Hill is located in central Belize, amidst the rolling karstic hills that border the Roaring Creek river valley. The site was occupied during the Classic period, from ca. AD 250 onwards, and was abandoned, as were most sites in the area sometime during the Terminal Classic, between AD 830 and 950 (Awe and Helmke 2007). Once the homestead of a lineage or extended family, Pook's Hill is a type of site known as a *plazuela* and consists of the ruined remains of nine masonry platforms that face onto a small plaza, hence its designation (Fig. 1; see also Fig. 8). Atop these platforms were perishable superstructures that were used for a variety of purposes, including residences. Also among these structures were a sweatbath to the northwest and a shrine to the east that served as the mausoleum wherein prominent lineage members were buried.

The architectural remains documented within the Roaring Creek valley have allowed basic reconstructions of the socio-economic hierarchy, especially when architectural size, surface area and complexity are used as indices of affluence. Based on settlement surveys conducted in the area between 2001 and 2003, ca. 300 solitary house mounds, 18 *plazuelas*, and 4 minor and major centers have been discovered. These figures result in an average density of 181 structures per square kilometer, a relatively high den-

Fig. 1 The archaeological site of Pook's Hill, Belize, as it appears today, following archaeological excavations and architectural consolidation efforts. Photograph by Christophe Helmke.

sity for the central Maya lowlands (Helmke 2009: 200-202). The solitary house mounds are thought to represent the remains of agrarian households of small nuclear families and amount to ca. 93% of the total number of sites documented to date. In contrast, the *plazuelas*, including Pook's Hill, together represent less than 6% of the sites documented in the settlement survey. Assuming that structures housed approximately the same number of individuals, the percentages of sites allow us to roughly estimate to the portion of the populations belonging to one or the other social strata, since a large proportion of the population lived in what are now house mounds, whereas few lived in more affluent households. This conclusion is borne out by the associated artifactual finds, since *plazuela* groups tend to exhibit a greater diversity of artifacts, produced at a higher quality along with a range of exotic goods, albeit in small quantities when compared to palatial complexes within the epicenters of the larger minor and major centers. At Pook's Hill, for instance we see a greater incidence of food processing implements, such as granite *manos* and *metates*, used to process maize, than say, chipped flint adzes used in agrarian activities, to clear fields and till the soil (Helmke 2001). In addition, small quantities of greenstone have been found, as well as different highly decorated ceramics, including polychrome serving vessels and molded-carved vases (*ibid.*). Furthermore, the faunal remains reveal that the inhabitants had a steady access to venison as well as tropical parrotfish (*Scaridae*), imported from the Caribbean coast (Stanchly 2006). These features imply that the inhabitants were relatively affluent, although no evidence has been found to suggest that they were elites, or bore relations with the ruling class that inhabited the minor and major centers of the area. It is in this regard that the inventory of musical instruments found at Pook's Hill are important, since they appear to represent the set of instruments used by a non-elite, middling social group.

Before archaeological investigations began at Pook's Hill, the eastern shrine had been trenched by looters, evidently in search of burials and associated artifacts that could be sold on the black market. With the start of archaeological investigations in 1999, the site was mapped and salvage excavations were conducted, focusing on the looters trench that affected the shrine. Between 2000 and 2005, the structures to the west, north, and east of the site's plaza were all cleared and tested, as well as partially consolidated for tourism. In the process it was found that large accumulations of trash, known as middens and

deposits that are designated as terminal occupation debris, were piled along the base of the platforms, especially in the corners at either side of stairs. These deposits contained a large variety of artifacts and testify to the daily activities that were conducted at the site, including the production and consumption of foodstuffs and beverages, small-scale craft production of textiles, stone tools and objects of bone, but most importantly to the present study, the production of music (Helmke 2001, 2006a-b). These artifact-rich deposits were all found at the base of masonry structures and occurred especially as concentrations on the plaza floor, at the foot of the buildings and at interior corners, as though detritus that was swept up and out of pedestrian passage (Helmke 2006a: 182-183). One particularly large deposit of terminal occupation debris partially choked off the sweatbath and represents a later phase that followed the disuse of this building (Helmke 2006b). As such, whereas these deposits provide exceptional information pertaining to the final activities that were conducted at the site, the contexts of the artifacts themselves are disassociated from the place in which they were originally used. Thus, in this particular case, we have not noted any higher degree of concentration of ocarinas (see below) associated with either of the excavated structures, nor a clear patterning between their incidence with domestic or ritual structures (Forbes 2004: 69-91).

Musical implements found at the site are many and include fragmentary bone rasps; turtle shells and deer antlers probably used in combination as percussion instruments; a tubular air-spring flute made of clay; but most importantly, a large collection of ceramic effigy ocarinas. It is on these instruments that we will focus our study, and in particular on a subset that are modeled to represent avian figures. Through an analysis of the physical and musical attributes of these effigy ocarinas and their relation to the broader context of the Pook's Hill archaeological site, we examine how these attributes can elucidate the potential uses of the avian ocarinas so prevalent at the site. However, before we examine the avian ocarinas, we will provide a synoptic overview of the other musical instruments found at the site and contextualize these against those found through the Maya Lowlands, in order to better appreciate the place of ocarinas within the register of musical instruments documented at Pook's Hill.

The Musical Consort in the Maya Area: Pook's Hill in Context

Ceramic ocarinas constitute the bulk of the musical implements discovered, not only at Pook's Hill, but also at the vast majority of Lowland Maya sites (Healy 1988). Based on count alone and considering the number of specimens recovered, we can say that 93% of musical instruments at Pook's Hill are ocarinas (ca. 79), with the remaining 7% comprising various idiophones and membranophones and one tubular air-spring flute made of clay similar to an artifact found at Pacbitun (Belize) (Cheong *et al.* 2014: 179). In order to better characterize and contextualize the inventory of musical instruments found at Pook's Hill, we will briefly compare these to others found at nearby sites in the Roaring Creek valley and to select sites in the greater Maya area. In the latter case, we will focus in particular on the murals of Bonampak (Chiapas), and luckily, in this regard are Miller and Brittenham's (2013) recently published watercolors of the murals, which provide heretofore unprecedented details of the instruments depicted. Such comparisons enable us to better situate the music of an affluent and non-elite group, versus the consort assembled as part of regal celebrations within site epicenters.

Characteristically, and in keeping with examples from the Maya Lowlands, musical rasps are usually made of bone, with pronounced parallel grooves incised into one face of the bone, with a solid object, such as a stick, rubbed along the grooves to produce a sound (see Willey *et al.* 1965: 496, Fig. 305j-k).[1] At Pook's Hill one rasp has been discovered along the base of the western structure (Structure 4A), and it was made of deer antler, from either White-Tailed Deer (*Odocoileus virginianus*) or Red Brocket Deer

1 The largest known example of a musical rasp in Mesoamerica is from the Zapotec archaeological site of Monte Albán, in Oaxaca, where the rib of a whale was fashioned into a rasp, incised with four different sets of grooves (see Stevenson 1976: 59; Sánchez and Higelin 2014: 103-106).

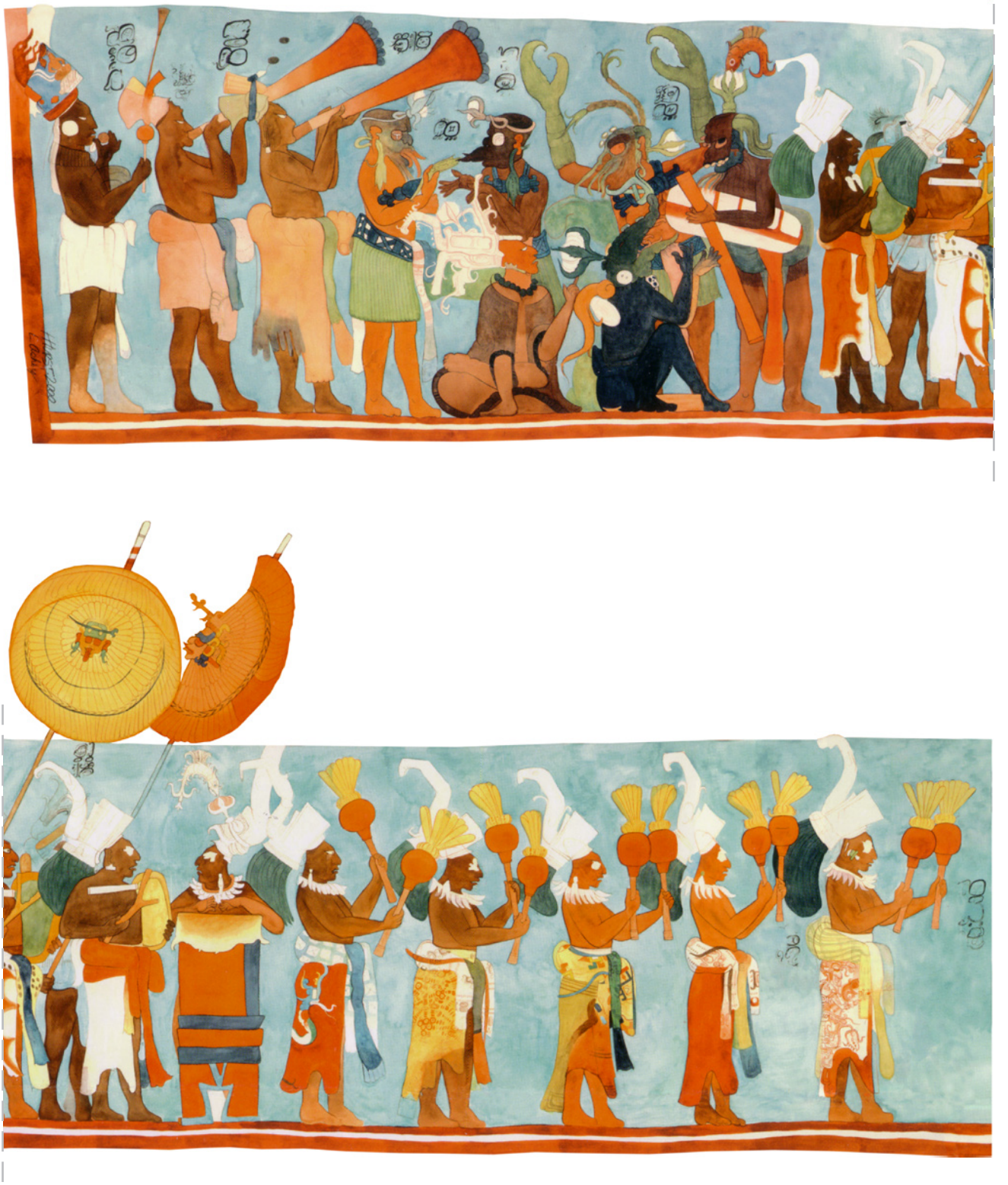

Fig. 2 The musical consort represented in the polychromatic murals at the site of Bonampak, Mexico (Structure 1, Room 1). Watercolor rendition by Heather Hurst and Leonard Ashby, after Miller and Brittenham 2013; courtesy of the Bonampak Documentation Project.

(*Mazama americana*) (Helmke 2001: 62). In the nearby cave of Actun Tunichil Mucnal a slate rasp has been found as part a ritual assemblage, demonstrating the close association between music and particular cave rituals (Helmke 2009: 396, 429, Fig. 6.34).

Among the percussion instruments that prevail in the iconography of the Classic period are free-standing drums, open at their base, and covered with a membrane made of animal hide that would have been struck by the hands of a player. Perhaps the most famous example is depicted in the murals at the site of Bonampak, where the vivid polychromatic murals show a festivity, celebrating the designation ceremony of the heir apparent (Fig. 2). As part of the revelry masked dancers perform a play to the accompaniment of a band that includes a long line of percussionists, including one beating a standing drum, and three trumpeters. Aside from the examples of large wooden drums – of which only a handful are preserved in Mesoamerica, the remainder having long since decayed due to the tropical climate – are smaller drums fashioned of clay. Well-preserved examples of such goblet drums are known from several sites in the Maya area, including the site of Barton Ramie, just 15 km to the northwest of Pook's Hill (Willey *at al.* 1965: 566; see also Martí 1968: 49). Whereas one such specimen is accompanied by a glyphic caption that can be read as *lajab*, the etymology and semantics of this term remain largely unclear (Houston *et al.* 2006: 176). Possible examples of clay drums are known for Pook's Hill (Helmke 2001: 62) and several of the nearby caves, including the Laberinto de las Tarántulas (Helmke 2009: 247-248) and Actun Tunichil Mucnal (*ibid.*, 393, 425-429), important ritual sites in the vicinity of Pook's Hill. Unfortunately, due to their fragmentary condition little can be said about this type of instrument. Some of the drawings rendered on the walls of Najtunich cave in Guatemala, show small processions of priestly figures carrying such small ceramic drums, thereby confirming the presence of music in cave rites (Stone 1995: 140-141; Helmke 2009: 250-251) (Fig. 3).

Fig. 3 A group of pilgrims represented in the rock art within the cave of Najtunich, Guatemala. Note the percussion instruments that they are playing, including a gourd and small ceramic drum (above), as well as hand rattles and a turtle carapace (below). Drawings © Andrea Stone, after Stone 1995: Figs. 6-22 and 6-23. Reproduced with permission of the University of Texas Press.

Another common percussion instrument of the Maya was a de-fleshed turtle shell, which according to iconographic sources was usually struck with a deer antler. Twelve fragments of turtle shell plastron have been recovered at Pook's Hill that have been identified as *hickatee* or Central American river turtle (Stanchly 2006: 104). All of these fragments are calcined on both their exterior and interior surfaces, suggesting that they were burned following deposition at the foot of the northern building (Structure 1A). In the Bonampak band, three of the percussionists are showing striking turtle shells with deer antlers. This type of instrument appears to be of great antiquity since greenstone skeuomorphs are known for the Preclassic Olmec (Taube 2004: 91, Fig. 40a) and an early Maya example is depicted in the Protoclassic murals of San Bartolo in Guatemala (Taube 2009: 48-49). In the latter example

Fig. 4 A detail of the murals from the site of San Bartolo, Guatemala, showing the Maize god performing a dance, while drumming on a turtle shell carapace with deer antlers. Drawing by Heather Hurst, after Taube et al. 2010.

we can see the Maize god vehemently striking a turtle shell that is hung around his neck, as he dances out of the underworld, a metaphor for his resurgence and resurrection (Fig. 4).

It is unfortunate that none of the large trumpets, likely made of a perishable substance, such as wood, that are seen in several scenes of the Classic period are preserved. Yet, their importance is made clear based on the context in which these are depicted. One such scene is represented in the murals of Bonampak, where at least two individuals are shown blowing these large trumpets. They are leaning back, evidently to support the weight of the instruments. Similar trumpets are also shown in the ensuing battle scene, giving us a sense of the music that accompanied military encounters. Other courtly scenes in Maya iconography show the pairing of wooden trumpets and conch shells used as trumpets (Fig. 5). Whereas conch shell artifacts are known from Pook's Hill, none were fashioned into trumpets. Another such example, however, is known from the cave of Actun Uayazba Kab – an additional cave in the area – where a nearly complete, partially worked conch shell has been found; a specimen that may well have been intended to be a musical instrument. The last trumpeter in the Bonampak scene holds a long and narrow trumpet in one hand, as well as what may be a percussion instrument in the crook of his arm. He also holds to his mouth something that resembles a whistle, or ocarina.

Whereas the material of the small trumpet is unknown it is somewhat reminiscent of a special category of aerophones documented archaeologically. One such fragmentary specimen has been found at Pook's Hill, where it was discovered within a trash heap that choked the sweatbath, a deposit that accumulated after the structure fell into disuse (Helmke 2006b: 78-80). This aerophone matches other instruments described as "tubular air spring flutes," such as that found at Pacbitun (Cheong *et al.* 2014: 179, Fig. 3a), which are small tubular flutes with a series of finger holes along the shaft, terminating in a flaring end with a medial bulge forming an additional resonating chamber. An exceptionally well preserved example is known for Cahal Pech (Audet 2006: 163), and based on other examples in the National Collections in Belmopan, it is clear that thin spiraling blades or "propellers" were appended to the tip, often made of shell or bone, undoubtedly functioning as decorative features.

Finally, the five musicians leading the band at Bonampak are all shaking matching pairs of large vessel rattles, making it clear that rattles also figured prominently among rhythmic instruments. The original ones, likely made of gourd, have not preserved archaeologically, but rattling instruments are also found among ceramic objects, particularly in the supports of large serving vessels and as figurines.

Despite this review of the relatively wide array of musical instruments used during the Classic period in the Maya area, and to a certain extent in Mesoamerica generally, we should recall that the iconographic sources are biased towards the elite, and in this case their musical instruments, tastes and pageantries. As such the picture that emerges from such iconographic and epigraphic sources differs in many respects from the material assemblages recovered at archaeological sites. The overlap in instrumentation, including the possible presence of a ceramic aerophone in the band at Bonampak, suggest a shared body of instrumentation among household sites such as Pook's Hill and the epicenters of the regal elite; however, an important musical distinction be-

Fig. 5 A palatial scene showing the ruler of the site of Motul de San José receiving envoys in his throne room. In the background musicians play on large wooden trumpets and a conch shell, one using a hand as a mute. Roll-out photograph of vase K1453, © Justin Kerr.

tween those depicted at Bonampak and Pook's Hill is the great abundance of effigy ocarinas, such as the ones that will be discussed at length below. Nevertheless, we must recall that these differences do not only reflect social inequalities, but also differential preservation conditions and as such we should consider ourselves fortunate in that so many musical instruments have survived the vagaries of time in the tropical rainforest of the Maya area.

Survey of the Ocarinas at Pook's Hill

In all there are 112 sherds of ocarinas, or effigy clay whistles that have been found at Pook's Hill. These represent up to 79 discrete single or double-chambered ocarina specimens, but most are quite fragmentary. Only about three dozen of the ocarinas retain their form – with most of the body intact – and of these, only thirteen instruments are capable of producing some aerophone-like sound. The ocarinas found at Pook's Hill include a variety of identifiable forms, including animals – such as birds, bats, dogs, and mammals – as well as other figurine shapes such as anthropomorphic entities, supernatural dwarves, and parts of human figures including headdresses (Forbes 2004: 35; Halperin 2014: 157-158, 230-231). There are also a number of instruments that are not identifiable as particular shapes. Many of these unidentifiable instruments are small, high-pitched whistles without stops.

Instruments similar in construction to those found at Pook's Hill have been referred to by ethnomusicologists and archaeologists as globular flutes (Martí 1968), whistles and whistle flutes (Boggs 1974; Flores and Flores 1981), and ocarinas (Martí 1968; Forbes 2004; Halperin 2007), the latter being the term that predominates in the archaeological literature, and therefore the one preferred here. The Hornbostel and Sachs (H-S) classification for the crested-avian effigy ocarinas at Pook's Hill is 422.211.3 (Hornbostel and Sachs 1961 [1914]; Jairazbhoy 1990), indicating that they are single vessel flutes with external ducts and finger holes. Instruments of this type have been found across the Mesoamerican cultural area (Martí 1968: 107).

Among these instruments a sub-group of crested-avian ocarinas distinguishes itself from a category of physically larger ocarinas. For instance, two larger avian ocarinas, a scalloped bird (Oca-

	Total
Anthropomorphic entities (inc. dwarfs, and headdress)	11
Birds / Avian figures (inc. owls, turkeys, crested and scalloped avians, etc.)	19
Bats	1
Mammals	2
Dogs	5
Unidentified	4
No diagnostic features	35

Tab. 1 The total distribution of effigy ocarina types found at Pook's Hill. After Forbes 2004: Tab. 5 and 6.

Description	Number of ocarinas	Ocarina numbers
Crested Avian	7	Oc 1, 3, 6, 8, 12, 59, 76
Unidentified Avian	5	Oc 29, 39, 43, 73, 75
Owl	3	Oc 2, 48, 77
Scalloped Avian	3	Oc 4, 38, 51
Turkey (?)	1	Oc 60

Tab. 2 The distribution of avian ocarina types found at Pook's Hill.

rina 51) and an owl (Ocarina 48), both share the same H-S classification as the crested-avian ocarinas (422.211.3). However, the scalloped bird is constructed so that the tail serves as an external duct, and a stop is placed in the middle center of the breast. Perforations through the neck of the bird permit it to be suspended, although its substantial volume of 221.70 cm^3 (Forbes 2004: 33) impacts on the practicality of wearing it. The owl features an external duct and two stops on its back. Like the scalloped bird, it is also of a substantially larger size than the smaller crested-avian ocarinas, with a total volume of 124.93 cm^3 (*ibid.*).

In the context of Pook's Hill, these identifiable sub-groups are formed by characteristics such as size; performance hand positions, including whether the stops are covered with the thumbs on the back of the instrument or the index fingers on the top or front; and the figurine shape, as in the case of the set of crested-avian ocarinas. At Pook's Hill, two distinct sub-groups of avian ocarinas are easily distinguishable by form and size: that of the larger ocarinas with volumes exceeding 100 cm^3 , and that of the smaller crested-avian ocarinas that do not exceed 14 cm^3. These two categories provide a useful starting point for further analysis of the potential of form and acoustic properties in deducing instrument function.

As can be seen in Table 1, avian figurines are the most prominent shape identified at Pook's Hill. In this avian figurine grouping, there are a variety of bird types that have been identified (Table 2). They differ in shape, size, and the number of stops, making them distinct in spite of their shared avian form. Of the seven small ocarinas that have been identified as depicting crested-birds, three are still sufficiently intact to produce sounds without any reconstruction or modification (i.e. Ocarinas 3, 8 and 12). They have a

single chamber with two small nubbin supports as feet, shaped wings on the dorsal surface, and two stops of equal diameter perforating each wing. Although the remaining four crested-avian ocarinas have been found in a fragmentary state (Ocarinas 1, 6, 59, and 74), the effigy heads are preserved and can therefore be identified as belonging to the same grouping. What species these ocarinas represent is not entirely clear, however, it may well be that they were meant to depict a great curassow (*Crax rubra*) or a crested guan (*Penelope purpurascens*) given their marked similarity to these local species (Beletsky 1999; Forbes 2004: 57) (Fig. 6).

One interesting fact is that five of the crested-avian ocarinas appear to have formed a set (i.e. Ocarinas 1, 3, 6, 8 and 12) (Fig. 7), which were all found in the same area, in the northwestern portion of the *plazuela*, in a deposit of terminal occupation debris designated as Cluster 4, which

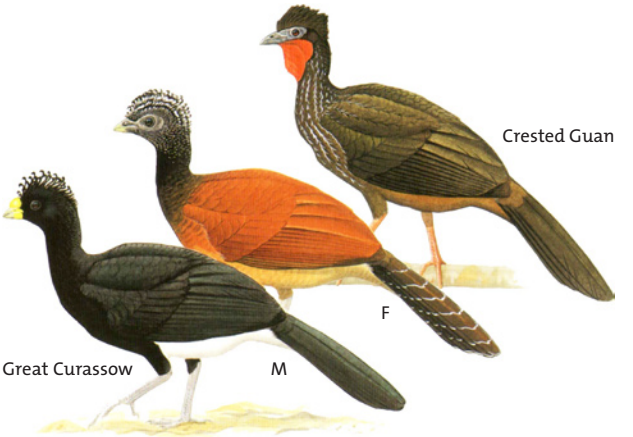

*Fig. 6 Crested avian species that may have inspired the ocarinas of Pook's Hill, including the great curassow (*Crax rubra*) and a crested guan (*Penelope purpurascens*). Watercolors after Beletsky 1999.*

Fig. 7 The crested bird ocarinas from Pook's Hill: a) Ocarina 1, b) Ocarina 3, c) Ocarina 6, d) Ocarina 8, e) Ocarina 59, f) Ocarina 12, and g) Ocarina 76. After Halperin 2010: Fig. 11.

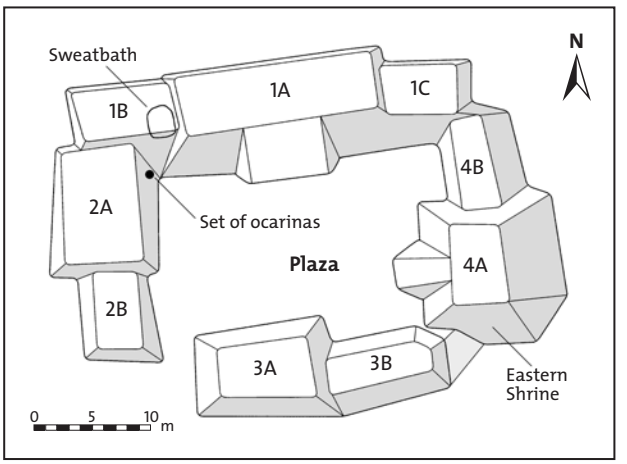

Fig. 8 Map of Pook's Hill showing the distribution of masonry structures that constitute the archaeological site. Note the location of the site's sweatbath, shrine and the find spot of the set of avian ocarinas. Map by Christophe Helmke.

is associated with the entrance to the sweatbath (Helmke 2006b: 79-80) (Fig. 8). That these were part of the same set is also suggested by the shared form of the head and body as well as the fact that the surviving crests feature perforations either at the top or in conjunction with the eye indicating that they were once suspended. The shapes of Ocarinas 1 and 8 indicate that perforations were located right at the base of the crest, which snapped off on these two instruments. The context of the find as well as the attributes of the ocarinas all suggest that these once formed part of a set that was worn as a necklace, wherein the ocarinas formed five incremental sizes. The smallest ocarina measures 2.4 cm in length (Ocarina 12), while the next larger size measures 3.2 cm (Ocarina 8) and the largest measures 4.0 cm (Ocarina 3). Although only the heads of the two largest ocarinas remain, based on extant measurements and assumed proportionate increase in size, these would have measured 4.7 cm (Ocarina 6) and 4.9 cm (Ocarina 1) in length, respectively.

Pook's Hill is a residential site that has been intensively excavated and as such its artifactual sample is representative of *plazuela* groups in particular, and non-elite residential sites in the Belize River Valley generally, but it differs in some respects from the samples of larger sites and monumental epicenters inhabited and utilized by the high elite. Distinctive features of the effigy ocarinas of Pook's Hill include their quantity as well as the large number of animal effigy ocarinas found at this one site; the absence of larger figurines presumed to represent deities or ancestral figures (see Eberl 2000; Halperin 2014); and the absence of tubular flutes and instruments with more than two stops, with the exception of the single tubular air-spring flute. Together, these characteristics point to some localized variations in instrument usage that was likely influenced by regional and social factors.

Sounding Capabilities of the Three Playable Crested-Avian Ocarinas

In July 2012 the senior author recorded all of the playable ocarinas in the Pook's Hill assemblage on a Zoom H2N Recorder, focusing particularly on the three ocarinas from the identified set of five crested-avian ocarinas (Ocarinas 3, 8, 12). Over a period of three days we were able to make recordings that adequately reflected the sound capabilities of the instruments, experimenting with both fingerings and air pressure, which was achieved by bending pitches starting with the fastest airspeed possible and slowly reducing airspeed until the instrument did not sound. For each instrument three different takes were recorded with the nine combinations possible on the two-stop ocarinas (including half-open finger positions). These recordings were later analyzed, and the pitches produced with fast, medium and slow air speeds were measured. In addition to these recordings, we also included a set of recordings initially made by Jonathan Forbes and the junior author in 2003, as part of an earlier study. Although Forbes only used two finger positions (open and closed) for a total of four combinations, these recordings proved similar to those of the senior author, which helped rule out player bias, or in other words demonstrated no significant variations between players. In total, this provided us with four sets of recordings for each of the three playable crested-avian instruments (Table 3).

Tab. 3 The measurements collected in kHz for the three playable crested-avian ocarinas. For reference, 2.00 kHz would be heard as approximately a B6 and 4.00 kHz as approximately a B7 in the equal-tempered chromatic system (see also Table 4).

Ocarina number	Left open Right open			Left open Right closed			Left closed Right open		
	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed
Nielsen OC 3	2.79 кHz	2.62 кHz	2.94 кHz	2.54 кHz	2.34 кHz	2.71 кHz	2.44 кHz	2.30 кHz	2.60 кHz
Nielsen OC 3	2.81 кHz	2.51 кHz	2.98 кHz	2.54 кHz	2.40 кHz	2.79 кHz	2.54 кHz	2.40 кHz	2.64 кHz
Nielsen OC 3	2.73 кHz	2.45 кHz	2.89 кHz	2.47 кHz	2.25 кHz	2.60 кHz	2.40 кHz	2.25 кHz	2.45 кHz
Forbes OC 3	2.59 кHz	2.45 кHz	2.80 кHz	2.36 кHz	2.14 кHz	2.57 кHz	2.36 кHz	2.15 кHz	2.64 кHz
Nielsen OC 8	2.70 кHz	2.53 кHz	3.05 кHz	2.46 кHz	2.33 кHz	2.80 кHz	2.45 кHz	2.31 кHz	2.76 кHz
Nielsen OC 8	2.59 кHz	2.40 кHz	2.68 кHz	2.35 кHz	2.19 кHz	2.41 кHz	2.28 кHz	2.02 кHz	2.52 кHz
Nielsen OC 8	2.74 кHz	2.36 кHz	2.90 кHz	2.50 кHz	2.12 кHz	2.78 кHz	2.38 кHz	2.12 кHz	2.59 кHz
Forbes OC 8	2.68 кHz	2.26 кHz	3.05 кHz	2.43 кHz	2.12 кHz	2.80 кHz	2.40 кHz	2.06 кHz	2.68 кHz
Nielsen OC 12	3.99 кHz	3.58 кHz	4.53 кHz	3.71 кHz	3.44 кHz	3.93 кHz	3.46 кHz	3.18 кHz	3.82 кHz
Nielsen OC 12	3.99 кHz	3.61 кHz	4.31 кHz	3.66 кHz	3.16 кHz	3.87 кHz	3.56 кHz	3.25 кHz	4.04 кHz
Nielsen OC 12	3.96 кHz	3.27 кHz	4.31 кHz	3.58 кHz	3.16 кHz	3.77 кHz	3.69 кHz	3.34 кHz	4.07 кHz
Forbes OC 12	3.85 кHz	3.66 кHz	4.25 кHz	3.58 кHz	3.25 кHz	3.99 кHz	3.61 кHz	3.11 кHz	3.69 кHz
Ocarina number	Left closed Right closed			Left closed Right half covered			Left open Right half covered		
	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed
Nielsen OC 3	2.10 кHz	1.95 кHz	2.40 кHz	2.56 кHz	2.43 кHz	2.69 кHz	2.54 кHz	2.42 кHz	2.67 кHz
Nielsen OC 3	2.14 кHz	2.05 кHz	2.29 кHz	2.44 кHz	2.25 кHz	2.60 кHz	2.71 кHz	2.40 кHz	2.85 кHz
Nielsen OC 3	2.16 кHz	1.91 кHz	2.22 кHz	2.37 кHz	2.11 кHz	2.45 кHz	2.51 кHz	2.35 кHz	2.58 кHz
Forbes OC 3	2.11 кHz	1.95 кHz	2.22 кHz	N/A	N/A	N/A	N/A	N/A	N/A
Nielsen OC 8	2.12 кHz	1.94 кHz	2.35 кHz	2.36 кHz	2.26 кHz	2.52 кHz	2.66 кHz	2.46 кHz	2.82 кHz
Nielsen OC 8	1.95 кHz	1.77 кHz	2.12 кHz	2.23 кHz	1.98 кHz	2.38 кHz	2.50 кHz	2.11 кHz	2.66 кHz
Nielsen OC 8	2.11 кHz	1.77 кHz	2.20 кHz	2.23 кHz	1.84 кHz	2.36 кHz	2.61 кHz	2.11 кHz	2.82 кHz
Forbes OC 8	2.15 кHz	1.65 кHz	2.41 кHz	N/A	N/A	N/A	N/A	N/A	N/A
Nielsen OC 12	3.07 кHz	2.76 кHz	3.29 кHz	3.22кHz	2.92 кHz	3.53 кHz	3.71 кHz	3.18 кHz	4.04 кHz
Nielsen OC 12	3.22 кHz	2.90 кHz	3.53 кHz	3.53кHz	3.00 кHz	3.85 кHz	3.82 кHz	3.44 кHz	4.10 кHz
Nielsen OC 12	3.11 кHz	2.72 кHz	3.22 кHz	3.36кHz	2.82 кHz	3.71 кHz	3.71 кHz	3.41 кHz	4.10 кHz
Forbes OC 12	3.13 кHz	2.82кHz	3.56 кHz	N/A	N/A	N/A	N/A	N/A	N/A
Ocarina number	Left half open Right open			Left half open Right closed			Left half open Right half open		
	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed	Medium air speed	Slow air speed	Fast air speed
Nielsen OC 3	2.54 кHz	2.47 кHz	2.64 кHz	2.21 кHz	2.08 кHz	2.34 кHz	2.51 кHz	2.29 кHz	2.60 кHz
Nielsen OC 3	2.81 кHz	2.62 кHz	2.89 кHz	2.51 кHz	2.27 кHz	2.79 кHz	2.73 кHz	2.49 кHz	2.85 кHz
Nielsen OC 3	2.64 кHz	2.37 кHz	2.77 кHz	2.30 кHz	2.21 кHz	2.40 кHz	2.53 кHz	2.29 кHz	2.73 кHz
Forbes OC 3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nielsen OC 8	2.70 кHz	2.50 кHz	2.92 кHz	2.36 кHz	2.22 кHz	2.68 кHz	2.52 кHz	2.31 кHz	2.76 кHz
Nielsen OC 8	2.55 кHz	2.23 кHz	2.64 кHz	2.22 кHz	1.97 кHz	2.31 кHz	2.46 кHz	2.20 кHz	2.64 кHz
Nielsen OC 8	2.63 кHz	2.20 кHz	2.92 кHz	2.26 кHz	1.97 кHz	2.46 кHz	2.40 кHz	2.02 кHz	2.55 кHz
Forbes OC 8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nielsen OC 12	3.58 кHz	3.25 кHz	3.85 кHz	3.41 кHz	3.05 кHz	3.66 кHz	3.64 кHz	3.09 кHz	4.01 кHz
Nielsen OC 12	3.87 кHz	3.46 кHz	4.04 кHz	3.41 кHz	3.05 кHz	3.77 кHz	3.53 кHz	3.25 кHz	4.10 кHz
Nielsen OC 12	3.85 кHz	3.41 кHz	4.01 кHz	3.25 кHz	2.96 кHz	3.74 кHz	3.58 кHz	3.32 кHz	3.77 кHz
Forbes OC 12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Ocarina number	Total length	Approximate interior volume of ocarina	Lowest measured pitch	Highest measured pitch
Oc 01	4.9 cm*	—	N/A	N/A
Oc 03	4.0 cm	13.07 cm^3	A#6 and 42 cents	F#6 and 12 cents
Oc 06	4.7 cm*	—	N/A	N/A
Oc 08	3.2 cm	7.50 cm^3	G5 and 88 cents	F#6 and 52 cents
Oc 12	2.4 cm	3.89 cm^3	E6 and 54 cents	C#7 and 37 cents

Tab. 4 The recoverable measurements and tonal ranges of the full set of five crested-avian ocarinas.

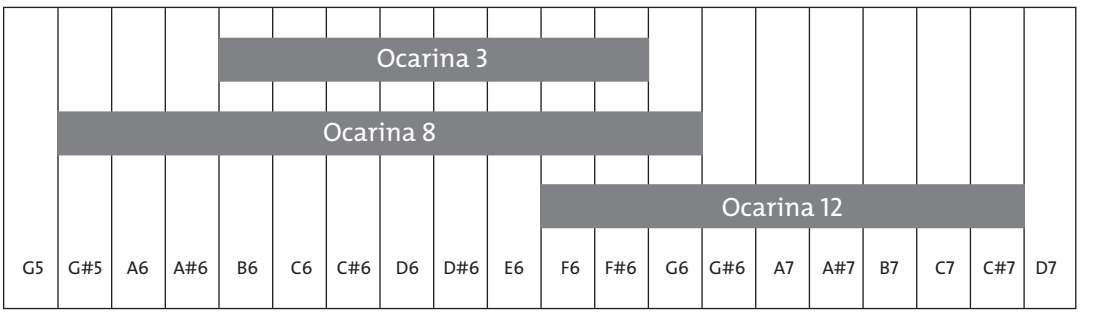

Fig. 9 Graph depicting the overlap of the ranges of the three playable crested-avian ocarinas.

As a set, the three ocarinas provide a flexible tonal range (Table 4 and Fig. 9). The range of Ocarina 3 overlaps with the larger range of Ocarina 8, while Ocarina 12 expands the range of the full set by nearly a fourth. Additionally, it must be remembered that two additional ocarinas were included in the set and likely further impacted the range available for players in pre-Columbian times. Ocarinas 1 and 6 likely had slightly lower pitches than the others in the set, corresponding to their larger size, although their ranges cannot be determined since the vessels of these instruments are fractured beyond repair. Considering that these instruments were worn as a necklace, the musical capabilities would have been expanded if we allow that they represented a single musical entity composed of multiple, perhaps interchangeable parts.

Similar to Susanne Rawcliffe's (2007) considerations concerning the importance of expressivity in clay instruments, we found that the fundamental was less sonically informative than the general palette of sound possibilities presented by each crested-avian ocarina and its individual fingering. This palette included the use of interchangeable instruments and variable airspeeds by players to achieve scooping or bending effects in pitch. Combinations of airspeeds were likely significant in achieving the desired aesthetic results; therefore, the range provided for the instruments includes the entire range that was achievable through varying airspeeds and fingerings.

From a European musical perspective there is a tendency to conflate stops with pitch, but this should not be the case. At least for crested-avian ocarinas, stops might be better conceptualized as a tool that widens the total audio potential when used with variable airspeeds. Although the window of potential may seem limited by use of only one or two stops, the creators of these instruments no doubt knew the full range of sound available with every finger and air speed combination. If stops are approached as tools for expanding the sounding capabilities of aerophones

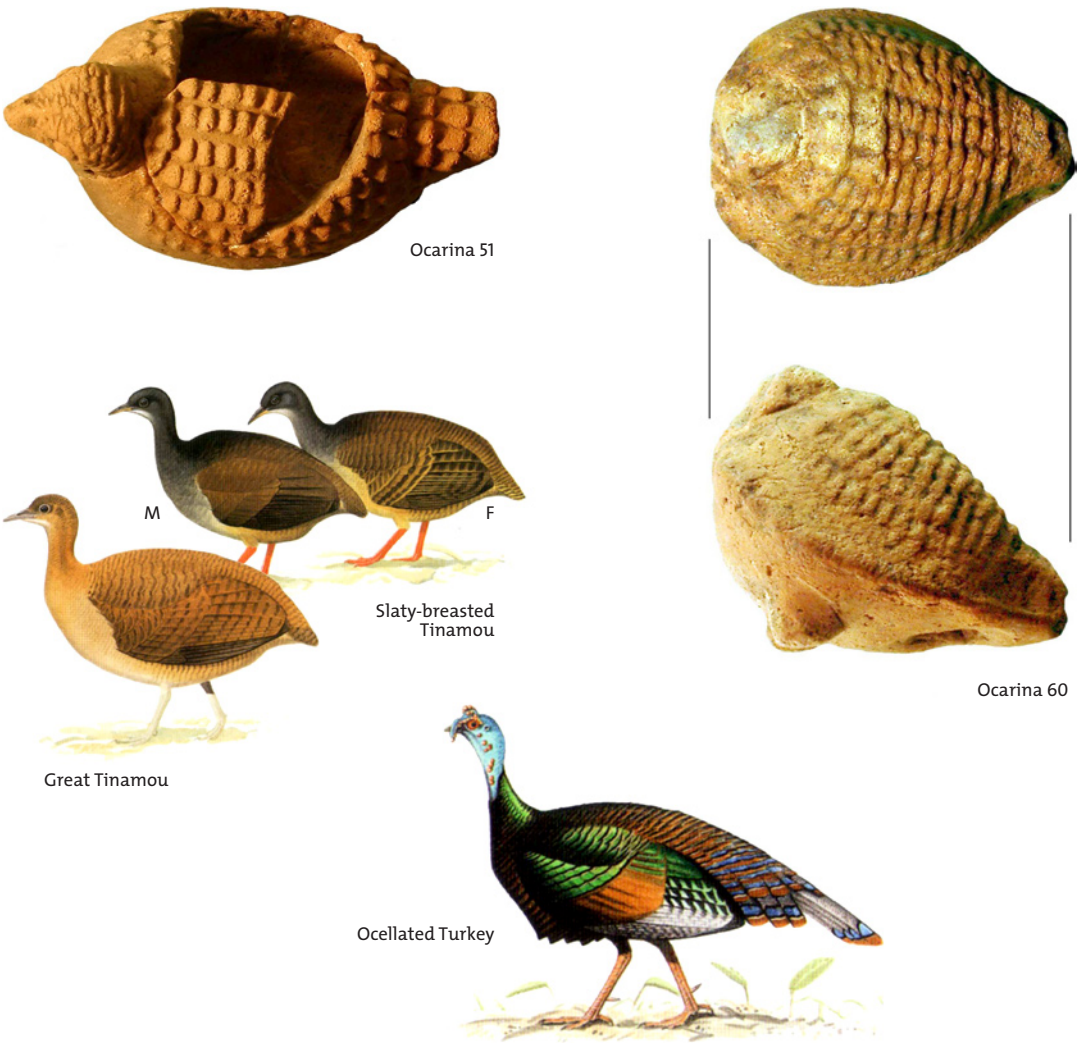

Fig. 10 Examples of ocarinas designated as scalloped avian effigies, compared to local birds. Ocarina 51 measures 11 cm long, Ocarina 60 6.9 cm long. Photographs by Christophe Helmke; watercolors after Beletsky 1999.

rather than as constraints outlining "pitches," a much wider range of choices is available to these instruments, allowing for a much more diverse sonic palette of possibilities.

Relationship of the Ceramic Instruments to their Environment

In light of the environment in which they were found, we attempted to compare the sounds of the three crested-avian ocarinas to local bird calls, including those of the great curassow (*Crax rubra*) and crested guan (*Penelope purpurascens*). While the ocarinas share an overlap in pitch and ambitus with the ranges of bird calls represented by these two species, this comparison only highlighted the potential of mimicry and its association without substantiating the extent to which their sounding capabilities were intended as exact or even symbolic mimicry of native bird life.

The sonic relationship between local fauna and effigy ocarinas found at Pook's Hill exists in a wider capacity than for just the crested-avian ocarinas. For instance, we can also hear sonic parallels between two "scalloped bird" ocarinas (Ocarina 51 and 60) that may represent a wild turkey (*Meleagris ocellata*) and Slaty-breasted Tinamou (Fig. 10), and the owl ocarinas (Ocarina 48)

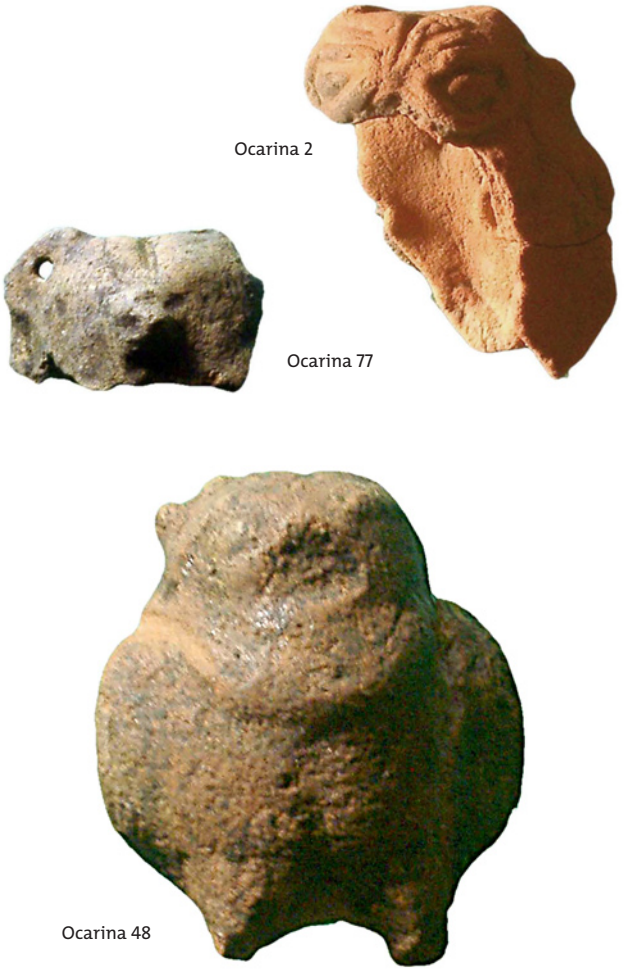

Fig. 11 Examples of owl ocarinas from Pook's Hill. Specimens are rendered to scale. Ocarina 48 measures 6.4 cm high. Photographs by Christophe Helmke.

(Fig. 11). These instruments share the capacity to roughly mimic their avian counterparts. The relationship between the sounding capabilities of effigy ocarinas and their counterparts in the local environment is observed elsewhere in Mesoamerican organology, including instrument imitations of sounds like rain and wind (Both 2006: 319). Samuel Martí (1968: 129) has made similar observations of imitation regarding owls for figurines from Oaxaca, and additional mimicry has been found between figurine instruments found at the archaeological site of Yaxchilan, in Chiapas, and frogs (Velázquez Cabrera 2002: 75).

These effigy ocarinas constitute a significant sub-group of instruments that share a special relationship to their natural environment, setting them apart from effigy instruments depicting dogs and human figures where the relationship between the sonic capabilities of the instruments and their forms are less readily apparent. In spite of the apparent connections between effigy forms and sounds within this sub-group of instruments, additional symbolic relationships might have been invoked by instruments, potentially adding additional layers of meaning to artifacts that cannot be interpreted with the data at hand. The deliberateness of this correspondence should not be considered the only option, as the effigy ocarinas from Pook's Hill and other collections of instruments in the Belize River Valley demonstrate high levels of creativity in size and form employed by their makers (see Halperin 2010).

Instead of trying to conceptualize the musical capabilities of Pook's Hill crested-avian ocarinas within the framework of scales, it may be more useful to interpret the governing musical principle of effigy ocarinas at Pook's Hill as one that exploits the acoustic properties of clay through the experimentation and perfection of different types of ceramic wind instruments. In her study of West Mexican Flutes, Susan Rawcliffe concludes that expressivity may have been the primary objective in the creation of the flutes:

> "After years of studying, making, and playing clay wind instruments, it seems clear to me that with prehispanic flutes, exact pitch is a lesser value than expressiveness as offered by flexible pitch bending and timbral manipulations. With no fully standardized flute body shapes or mouthpieces, there can be no fully standardized scales; to date, there is no evidence of consistent pitches or intervals, nor of great interest in the harmonic series, nor for maximizing the pitch range. Although flute families usually share a characteristic timbre, potential playing techniques including the number of finger holes, and some interval similarities and pitch ranges, the actual details typically remain unique to each flute." (Rawcliffe 2007: 53)

A similar approach to instrument use and construction at Pook's Hill might explain the diversity of sounds produced on instruments that are otherwise very similar. Although the crested-avian ocarinas at Pook's Hill share a similar shape and smaller dimensions, ranging from just 2.40

to 4.95 cm in length, none of them are fully identical in either their physical attributes or sounding capabilities.

Deducing Functions of Avian Ocarinas from Design

Focusing on the physical attributes of the subset of small crested-avian ocarinas, these aspects are distinctive for a number of reasons, including their diminutive size and portability, the apparent ease with which they were created, and their relative abundance at Pook's Hill. In contrast to the larger ocarinas, some of which appear to have been made from molds, including those representing supernatural dwarves, owls, and scalloped birds, the crested-avian ocarinas were all modeled by hand and are particularly distinctive in terms of their practicality as items of personal adornment, as necklaces, for instance. Such necklaces could have been worn by either men, women, and/or children, as these items were widely accessible (Halperin 2014: 186). The largest crested avian found on the necklace with the five crested-avian birds has a total length of 4.95 cm and would not protrude significantly from the body when worn. In fact, a necklace of five crested-avians could have been worn without interfering in the mobility of the wearer as he or she performed hunting, farming, or domestic work.

In contrast, although some of the larger effigy ocarinas also have suspension holes (e.g. Ocarinas 7 and 51), wearing these would have proved cumbersome and interfered with many of the domestic activities necessary to maintain the household. As such it seems that these were worn for specific ritual or social occasions. Alternatively, they may have been worn by individuals who performed negligible amounts of manual labor. Based on the sounding capabilities of these larger instruments, it is probable that they were played in more intimate (and possibly indoor) settings, since these larger instruments produce lower pitches and their sound waves do not cover the same distance as those for smaller instruments.

The playing of both the crested-avian and larger ocarinas interferes with the audience's ability to see the details of the iconography. These two instrument shapes and sizes require different hand positions to accommodate the locations of the stops. For the larger ocarinas, including those representing owls (Fig. 11, Ocarina 48) and dwarves, the most natural hand position has the thumbs covering the stops on the back resulting in the hands covering at least some portion of the front figure. This hand position contrasts with that utilized for the crested-avian ocarinas, where the most natural hand position places the index fingers on the two stops located on the top of the instrument; however, since the crested-avian ocarinas are much smaller than the larger ocarinas, only the heads are easily visible when they are played. The unavoidable covering of detailed iconography during the playing of the instruments further supports a substantial decorative role for both the larger and smaller crested-avian ocarinas when not in use as sounding instruments. This decorative role of the instruments is further implied by their construction, since in addition to suspension holes, most ocarinas also exhibit small supports or nubbin feet so that these can stand as small statuettes or effigies.

Interpreting the Function of the Crested-Avian Ocarinas from their Musical Capabilities

Recent studies of Maya figurines have begun to dissolve the rigid boundaries formerly drawn between ritual and play (Stöckli 2007: 28-29; Halperin 2014: 200), allowing for increased variability in the potential roles of effigy ocarinas such as those found at Pook's Hill. The potential versatility of the sub-group of crested-avian ocarinas is further supported by their portability in the form of a necklace, indicating their likely presence in a number of contexts in the daily life of the wearer. In this light, the suspended crested-avian ocarinas could conceivably have had both ritual and practical uses, while the constraints in the construction of sound-making components in larger ocarinas may indicate less versatility of uses and a more singular purpose. The small crested-avian ocarinas would not really have interfered in the daily life of their owners and might have served practical functions, such as hunting and communicating across distances larger than the voice can carry, in addition to entertainment and ritual functions.

In considering their applications for hunting, the crested-avian ocarinas and several whistles that were played can replicate the sounds of birds of prey in the Belize River Valley, such as the black-hawk eagle. The semblance is similar enough that when the senior author tested the instruments several of the employees on the site initially believed the sounds were produced by a hawk. In considering the potential applications of this capacity of the instruments for hunting

around the Pook's Hill site, two contemporary uses of birdcalls in hunting provide clues. Hunters can locate birds by mimicking their calls, eliciting responses that convey their locations; alternatively, mimicking the calls of birds of prey can cause birds to momentarily freeze to avoid movement that would alert a predator of their location, creating an advantage for the hunter. The flexibility in the range of the crested-avian ocarinas allows for both of these potential uses.

The various crested-avian ocarinas and whistles found at Pook's Hill could additionally have been used for communication between some of the more distant households, the nearest house mound being located less than 42 m to the southeast. With the instruments readily accessible around the player's neck, these instruments might have served to communicate, and different types of signals could have been employed similar to contemporary traditions, such as whistling among the the Mazatec people of Oaxaca (Wilken 1979: 883). The presence of tonality in several Maya languages, including Yukatek, Chontal, Uspantek, and the Tzotzil (Campbell *et al*. 1986: 544), further supports the potential role of these instruments for practical communication between households and by household members. Such communicative properties of the instruments might additionally have contributed to ritual uses for communication with spiritual entities.

The crested-avian ocarinas might also have provided a source of entertainment or other social activities. The full range of Ocarina 8 spans nearly an octave, while Ocarinas 3 and 12 both have a range of approximately a fifth. The flexibility in the ranges of the instruments allows for the creation and replication of melodies, and given that they were in a set, the wearer of the necklace could have alternated playing among different ocarinas. Using the set of three intact crested-avian ocarinas, there is an approximate total range of an eleventh (G#5 to C#7), and the wearer of the necklace could easily switch between the various suspended instruments to play melodies more elaborate than those produced by a single ocarina. While only the one necklace has been identified at Pook's Hill, it is conceivable that such necklaces were widespread, given the number of similar small effigy ocarinas with suspension holes. If such necklaces were indeed commonplace, musical activity with these instruments could have been highly social with multiple wearers of necklaces producing music together.

In addition to their potential for collective performance with other similar sets of ocarinas, the crested-avian instruments might also have been utilized in ensembles with any number of other instruments discovered at the site, including the rasps, turtle shells, and possibly drums. Since no depictions of musicians playing instruments exist at Pook's Hill, it is unknown how diverse percussion instruments and ocarinas were organized into possible ensembles and utilized in various performance contexts; however, the portability of the suspended crested-avian ocarinas indicates a more direct presence in the daily life of the wearer than instruments, such as drums, which are predominantly stationary.

The potential uses of the instruments explored above could have fulfilled both secular and ritual or religious purposes, as these categories have significant potential for overlap (Taube 1989): Music may serve a religious or ritual purpose and entertain the participants concurrently.[2] Effigy ocarinas of similar size and structure have been found in ritual contexts nearby; for instance, several ocarinas, including a complete one representing a small, fattened and edible dog, have been found in a ritual deposit within Actun Tunichil Mucnal (Helmke 2009: 429, Fig. 6.33). The ritual placement of these similarly constructed ocarinas at Actun Tunichil Mucnal contrasts with their placement away from the eastern shrine at Pook's Hill, indicating the diversity of contexts in which this similar sub-group of instruments could be utilized.

Conclusion

The portability, forms, and sounding capabilities, of the crested-avian ocarinas indicate that these may have been multi-functional, while other ocarinas found at Pook's Hill, such as the larger owl and scalloped bird ocarinas, may have been crafted for very specific ritual purposes. Although the crested-avian ocarinas share many features with

2 The oratorio provides a fitting example of this area of overlap between secular and religious music function in the Western repertoire.

the other ocarinas found at Pook's Hill – including the material of manufacture and locations of finds – they also distinguish themselves as discreet objects of personal adornment that would have been readily accessible to the wearer, permitting their use in any number of circumstances. As a set of five, the ocarinas could have provided the wearer with a wide palette of sonic and asonic possibilities, extending musical and decorative potentials. In light of this evidence, the crested-avian ocarinas forming this set offer a rare glimpse into how such instruments may have functioned. While these instruments may have been used in ritual contexts with the other instruments found at the site, they could also have had overlapping, even practical uses.

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ARNAUD GÉRARD A., Mgtr., es físico, músico y constructor de instrumentos musicales. Trabajó como profesor de la Carrera de Física de la Universidad Autónoma Tomás Frías (UATF) de Potosí, Bolivia (1986-2010), y fue fundador y responsable del Laboratorio de Acústica *SoundLab* de la Carrera de Física, donde realizó investigaciones en acústica musical, organología y etnomusicología, siendo autor de varios artículos en el área. El programa de investigación contempló particularmente el estudio acústico y organológico de instrumentos musicales rurales de la zona andina de Bolivia. Asimismo, dictó clases como profesor de Acústica y Organología en la Carrera de Artes Musicales de la UATF. Actualmente es miembro de la Sociedad Boliviana de Física (SOBOFI), investigador asociado del Instituto de Investigaciones Físicas de la Universidad Mayor de San Andrés (La Paz), investigador adscrito al Instituto de Investigación Antropológica y Arqueológica de la Universidad San Francisco Xavier de Chuquisaca e ingeniero de sonido en *Acústica StudioLab* de Potosí.

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MARK HOWELL, Ph.D., is the Director of the Winterville Mounds (2006-present), a 12-mound Mississippian Period site and museum. Prior, he taught Music History at Fordham University (1999-2006) and Hunter College (1999-2004). More recently, he was a Senior Research Fellow with TOPOI in Berlin (2009-2012). Dr. Howell is currently working with Graeme Lawson, Jana Kubatzki, Arnd Adje Both, Ricardo Eichmann, and other colleagues, developing a master's level degree program in music archaeology for the Berliner Antike-Kolleg (Freie Universität Berlin and Humboldt Universität).

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KRISTINA NIELSEN is currently a doctoral student at UCLA with an interest in pre-Columbian Mesoamerican instruments and modern reinterpretations of pre-Columbian Mesoamerican music and dance. She completed her B.M. in piano performance at Western Washington University in 2009, and later studied in the Native American Language and Cultures program at the University of Copenhagen, where her interests in Mesoamerica and music converged. Her recent research projects include an analysis of avian ocarinas from Pook's Hill, Belize and researching the history of indigenous dances in Central Mexico. Kristina received her Masters in ethnomusicology from UCLA in 2013, and is currently researching the use of music and dance in the Los Angeles Danza Azteca community for her dissertation, which she will complete in June 2017.

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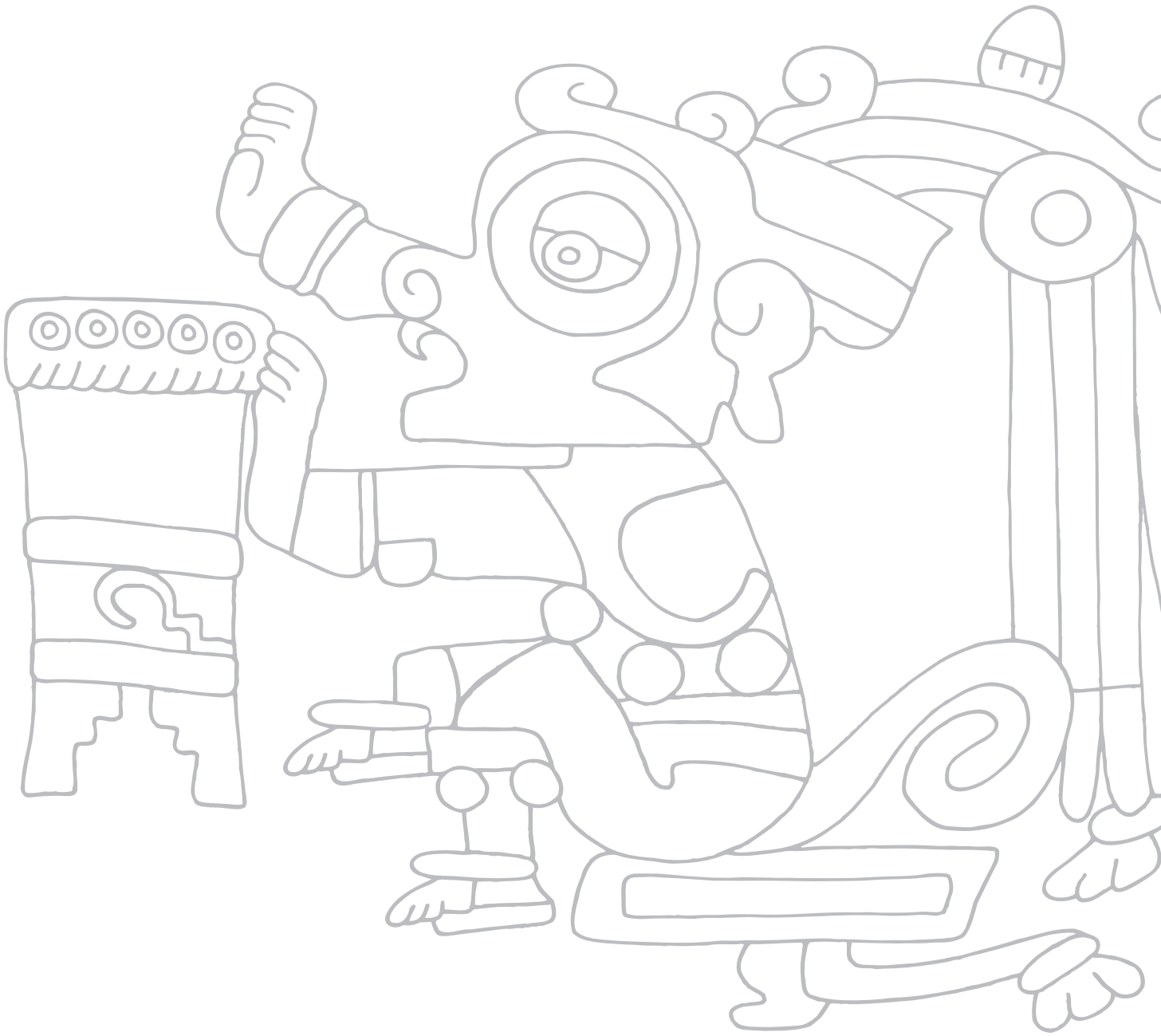

Flower World - Mundo Florido

Oh flowers we take,
oh songs we chant,
we enter the Reign of Mystery!
A least for one day we are together, my friends!

We ought to leave our flowers,
We must leave our songs
and go while the earth lasts forever!
My friends, enjoy; let's celebrate, friends!

Aztec song
Cantares Mexicanos fol. 35v., lin. 16-20

!Oh flores que portamos,
oh cantos que llevamos,
nos vamos al Reino del Misterio!
¡Al menos por un día estemos juntos, amigos míos!

¡Debemos dejar nuestras flores,
tenemos que dejar nuestros cantos
y con toda la tierra seguirá permanente!
¡Amigos míos, gocemos; gocémonos, amigos!

Canto azteca
Cantares Mexicanos fol. 35v., lin. 16-20